REMARKS/ARGUMENTS

Applicant responds herein to the Office Action dated July 14, 2003. A Petition for Extension of Time (three months) and the fee therefor are also enclosed.

Since the application is under a final rejection, applicant also encloses a Notice of Appeal petition to prevent the application from becoming automatically abandoned.

The applicant has amended the specification to provide a cross-reference to the PCT application. In addition, the applicant has noted the Examiner's comments and is enclosing herewith a certified copy of the priority document.

Substantively, the applicant has noted the "Response to Amendment" section which begins at page 2 of the Office Action. The applicant has further noted the "Response to Arguments" section which begins at page 6 of the Office Action. The applicant further notes the rejection of claims 1-10 under 35 U.S.C. §112, first paragraph, based on the assertion that the disclosure is non-enabling and further notes the rejection of claims 1-10 under 35 U.S.C. §112, first paragraph, on the basis that they fail to comply with the written description requirement. Applicant further notes the rejection of claims 1-9 under 35 U.S.C. §101 on the basis of the assertion that the absence of reproduceable and statistically meaningful data in support of applicant's statement that the 'apparatus' device of claims 1-9 and the "method of obtaining a desired DC electromotive force" of claim 10 contradicts the second law of thermodynamics and/or lacks enablement and/or is lacking in patentable utility, and responds to the foregoing as follows.

Specifically, the form of the response presents the applicant's own remarks that have been communicated to the applicant's undersigned representative (which have been only minimally edited for grammatical and idiomatic considerations).

I. Applicant's opinion about the rejection reasons in the 'Response to Amendment' section of Final Office Action

<< Rejection Reasons by Examiner>>

(I-1) Examiner raises a rejection reason that the disclosure is not enabling and lacks patentable utility based on following key grounds.

(I-1-1) First ground: Applicant must provide a plot of entropy as a function of time or the equivalent of it, in a manner that enables a straightforward verification of Applicant's statement that his invention contradicts the second law of thermodynamics and that the rectifying function of the device is able to operate without supply of energy. However, Applicant has provided no such plot. Accordingly, said Applicant's statement remains fully unsubstantiated.

(I-1-2) Second ground: The only plot based on Table 1 does not include any error bars and any explanation why this plot cannot be explained within the context of theory that does not contradict the second law of thermodynamics. Therefore, Applicant provides both the wrong kind of information and the wrong quality of information.

(I-1-3) Third ground: Neither the statistical significance of the allegedly measured voltage nor the source of the allegedly measured voltage can be ascertained at all based on the Supplemental Submission by Applicant, because (a) no error bars have been presented, (b) a forteriori no error analysis is available to explain the size of the possible error in the measurements, and (c) no estimate is given of the expected voltage predicted according to perfectly conventional statistical theory when one connects two substances with different chemical potential and/or different temperature.

(I-2) Furthermore, Examiner indicates that the material characterization of the "metal particles" is in stark contrast with the Declaration under 37 C.F.R. 1.132, because (1) Ge is not a metal but instead a semiconductor, (2) nothing in either the original specification or the Declaration explains how the "metal" particles are uniformly distributed, and (3) how they are made to be of uniform size. Based on these points, Examiner concludes that said Declaration does not substantiate but instead seriously contradicts Applicant's Specification.

<< Applicant's Opinion>>

Applicant does not agree with the Examiner's rejection reasons, particularly that the disclosure of the Application is not enabling and lacks patentable utility. Hereinafter, Applicant will present Applicant's opinion regarding the items the Examiner pointed out.

(1) Applicant's opinion about rejection reason "I-1-1"

The Examiner asserts that it is a requirement that Applicant must provide a plot of entropy as a function of time or the equivalent of it in a manner that enables a straightforward verification of Applicant's statement that Applicant's invention contradicts the second law of thermodynamics and that the rectifying function of the device is able to operate without a supply of energy. However, in opposition to the Examiner's assertion, Applicant does not consider that a plot of entropy is indispensable in verifying the enabling and the patentable utility of Applicant's invention. Applicant takes the standpoint that a plot of entropy is not an exclusive means for verifying the enabling and patentable utility of Applicant's invention and that the lack of presentation of a plot of entropy cannot be a basis for denial of the enabling and patentable utility of Applicant's invention. Also, Applicant takes the standpoint that it is improper to require a plot of entropy for Applicant's invention, as it is unnecessary and not easily obtainable data, for showing the enabling and patentable utility of Applicant's invention.

Applicant actually manufactured an apparatus according to the invention as shown in the attached reference figure 3 and measured power consumption in a resistor 8 connected to the apparatus on the assumption that the apparatus is located in a self-contained thermal equilibrium system. From the result of the measurement, Applicant could confirm continuous consumption of energy in the resistor 8. Heat generated by the consumption of energy in the resistor 8 is calculated as $\Delta Qt=V^2t/(4.2\times10\times10^6)$ cal per second (where, t is time and V is voltage applied to the resistor). From this, it can be estimated that the thermal equilibrium system itself supplies the electric energy consumed by the resistor and the energy for such supply is continuously generated in the thermal equilibrium system.

However, it is very difficult to understand the entropy state of the system, which means entropy variance according to time, because the difficulty index of the work of estimating or measuring the entire heat Q contained in the system is nearly infinite. Further, although the heat generated by the resistor 8 in the apparatus shown in the attached reference figure 3 can be calculated by an equation, $\Delta Qt=V^2t/(4.2\times10\times10^6)$ cal per second (where, t is time and V is voltage applied to the resistor), it is actually impossible to calculate or measure the temperature of the resistor 8 or the

heat contained in the resistor 8. In other words, it is actually impossible to calculate the parameters necessary for calculating the heat contained in the system, which include structural properties of the resistor (e.g., material and weight of each portion of the resistor body, metallic material of both connecting ends of the resistor, weight and specific heat of the same), thermal loss due to electric conductivity of the resistor, surface area of the resistor, thermal loss to cold areas in the system by convection of the atmosphere, thermal loss due to radiation, etc. Further, it is impossible to directly measure the temperature of the resistor 8, since there exists no thermometer capable of directly measuring minute portions of the resistor 8, the temperatures of which are different from each other. Therefore, a plot of entropy for the entire system cannot be obtained without knowledge of such parameters as described above.

An entropy value of a self-contained thermal equilibrium system is defined as a maximum constant which can be achieved by the entire heat Q contained in the system and cannot be increased any more. The fact that the voltage continuously measured at the opposite ends of the resistor 8 implies the continuous generation of heat by the resistor 8, and the entire heat Q in the system can be maintained constant only when the heat generated by the resistor 8 is a part of the entire heat Q (according to the first law of thermodynamics).

In a thermal equilibrium system, as shown in reference figure 3, when a switch 3 is turned on in a state in which all portions have the same temperature, the temperature of the resistor 8 rises to show a temperature difference with respect to the temperature of other portions. Compared with the thermal equilibrium state when the switch is off, this state implies that the entire entropy of the system has been decreased. Applicant takes the position that, in verifying the assertion of the present application, it is sufficient to confirm that the apparatus of the present invention functions so as to reduce the entire entropy of a thermal equilibrium system. It is nearly impossible and unnecessary to exactly plot the shape of the curve in which the entropy decreases over time.

(2) Applicant's opinion about rejection reason "I-1-2"

Applicant does not agree with the Examiner's viewpoint that Applicant provides both the wrong kind of information and the wrong quality of information, due to the fact that Applicant does not disclose any error bars nor any explanation why the plot based on Table 1 cannot be explained

within the context of a theory that does not contradict the second law of thermodynamics. The grounds for Applicant's opinion are as follows.

In the description on the plot value in Table 1 (please refer to "(2) in '4. Results of the Measuring and Applicant's Opinion' of the "Exhibit A to Declaration of Chang Je Cho Under 37 C.F.R. 132, which was filed on March 5, 2003), a general measurement value obtained from the measurement, 1 mV, which can cover at least ten times of a real error value, has been presented as a reference for the maximum of the error value. To Applicant's knowledge, there has been no discussion up to now on such concept as output data obtained outputted while spontaneously destroying a thermal equilibrium state in a thermal equilibrium system or error accompanying the output data. It is true that in general, error bars have been used as a reference for determining a probability of data in dealing with the data in existing non-equilibrium systems.

However, such error bars have been used as means for understanding synthetic error values about various non-equilibrium factors having no known cause. In principle, a thermal equilibrium system has no non-equilibrium factors. Further, it has no established non-equilibrium factor. In a state where statistical functions and meaning of error bars for the output data outputted obtained while spontaneously destroying a thermal equilibrium state have not been clarified, analysis or examination of with error bars on the output data may result in an erroneous conclusion. Applicant has drawn plots of error bars in respect of two exemplary samples, manufactured under the same condition, which have maximum output voltages of 82 mV and 65 mV, respectively. Then, the average of the two output voltages is calculated as 73.5 mV with a standard deviation of 6.0 mV (73.5 ± 6.0). In the drawn plots, Applicant can understand the use and meaning of the average value of 73.5 mV, but cannot understand the use and meaning of the error bars, the bars of 12 mV vertically extending up and down from the average value of 73.5 mV. The two measured values include the meter error of $\pm$ 0.1 mV together with a non-equilibrium factor due to temperature difference, which is not larger than $\pm$ 0.05 mV. These two error values have no relation to the 12 mV error bars. In the entire course of manufacturing the samples generating output voltages of 82 mV and 65 mV and measuring the output voltages from the samples, the only difference of related prominent conditions between the two samples is that the target for forming SnO_2 film (the film which is not in direct contact with nano particles) was used again for the sample of 65 mV after being used for the sample of 82 mV. As a result, it is reasonable to analytically conclude that they have an output voltage difference due to a difference in the degree of surface oxidation of the target

(a surface portion is more oxidized than an interior portion). This was confirmed by an increase of an electromotive force when a small quantity of O_2 gas is added to Ar gas. That is, the difference is an output voltage difference caused by structural conditions of the samples and is not the result of a participation of non-equilibrium conditions such as a temperature difference.

To Applicant's understanding, factors determining values for the plot of Table 1 are determined by suitability between energy retained by thermally moving electrons, sizes of nano particles, and a width of rectifying barrier. The portion due to minute temperature difference, which can participate as a non-equilibrium factor, has not been measured since it is even smaller than the meter error. Details thereof are described in Applicant's response opinion on rejection reasons 'I-1-3' and 'II-1'.

Descriptions on the portion contradicting the second law of thermodynamics for the plot values in the presented table 1 are can be found in lines 16 – 18 of page 1, lines 14 – 22 of page 5, lines 1 – 13 of page 18, lines 14 – 29 of page 28, etc., of the original specification. On an assumption that the description has not been understood well, Applicant presents the following description. The reason why the plot cannot be described on a theoretical basis which does not contradict the second law of thermodynamics is that this plot cannot be described by and does not accord with the second law of thermodynamics. Applicant thinks it natural that the invention cannot be described by the current scientific knowledge established on the basis of the second law of thermodynamics. The basis of above assertion will be described in detail hereinafter.

The core of Applicant's invention lies in an apparatus and method, which enable thermal energy in a heat source of a thermal equilibrium system to change by itself into electric energy which is a kind of dynamic energy. The object of discussion about the second law of thermodynamics in the present application is only to point out that the second law of thermodynamics cannot be used as a criterion for determining whether the invention is true or not, because the apparatus according to the invention is understood to have an effect which cannot be explained by the second law of thermodynamics and moreover does not accord with the second law of thermodynamics. The spontaneous voltage output of the apparatus of the invention in a thermal equilibrium system can be confirmed as true. The fact that this phenomenon does not accord with the second law of thermodynamics can be verified. Hereinafter, a basis for the fact that the voltage generated by the apparatus of the invention does not accord with the second law of thermodynamics will be presented.

There are various expressions for the second law of thermodynamics. In order to maintain objectivity, three expressions as follows are cited from textbooks.

i) *Expression 1*: in page 227 of Analytical Experimental Physics (By HARVEY BRACE LEMON, Professor of Physics, The University of Chicago and MICHAEL FERENCE, JR., Assistant Professor of Physics.),

"*The Second Law of Thermodynamics may be expressed in many ways. One useful expression is that of §214, that no self-contained system can cause heat to flow from a cooler to a warmer region indefinitely.*"

"*An electric refrigerator causes heat to flow from the cooler interior to the warmer exterior, but it is not self-contained; energy must be supplied to keep it working.*"

ii) *Expression 2*: In the same textbook,

"*Since all natural processes are irreversible and involve increases in entropy, we may generalize and, following Clausius, state that the Second Law of Thermodynamics is equivalent to the statement that the entropy of the universe is increasing and that the First Law is equivalent to the statement that the total energy of the universe is constant.*"

iii) *Expression 3*: In another textbook,

"*Change in nature progresses only in a direction from a state of 'order' to a state of 'disorder'. Nothing in nature changes from a state of 'disorder' to a state of 'order'." Gibbs describes the entropy of a system as a scale of "degree of mixed-up-ness".*

Applicant actually manufactured a plurality of samples of the apparatus of the invention and has continued tests for measuring the electric output from the samples. Reference figure 3 is a view showing a construction of a system for measuring the electric output from an actually manufactured sample, and reference figure 4 is a sectional view of the sample of the apparatus of the invention, for describing a method of forming Ge nano particles. It will be verified with reference to reference figure 3 that an output of electric energy from a thermal equilibrium system is a phenomenon which

does not accord with the second law of the thermodynamics.

Referring to reference figure 3, an electric circuit 6 disposed in a self-contained thermal equilibrium system includes a 10 mega-ohm resistor 8 and a lead switch 7 (which is extremely small and can be turned on/off by a magnetic field outside of the system) which are connected to each other. The 10 mega-ohm resistor 8 is connected by its opposite ends to a voltage measurement circuit 10 disposed outside of the system.

The thick line designated by reference numeral 9 represents a boundary line of the self-contained thermal equilibrium system. It is assumed that the space of the self-contained thermal equilibrium system has a volume of 0.5cm×1.5cm×2 cm. The smaller the space is, the shorter the time required in reaching the thermal equilibrium. The volume of 0.5cm×1.5cm×2 cm is sufficient in consideration of the size of the sample and volumes of various elements.

When the space is left intact for several hours in a state in which the switch 7 has been turned off, the space comes into a thermal equilibrium state in which all portions of the space have the same temperature. Since all portions of the space have the same temperature, there is no flow of heat. Entropy is defined to have a constant and maximum value in the thermal equilibrium state in which there is no flow of heat. Since there is no current, electrons and charges experience disorderly thermal activities. According to the first law of thermodynamics, the entire energy in the system has a constant value, and according to the definition of the thermal equilibrium system there actually exists only thermal energy to establish a thermal equilibrium state.

First, in a thermal equilibrium state, a magnet 11 is moved to approach the self-contained boundary 9, so as to turn on the lead switch 7. Then, voltage V is measured at the voltage measurement circuit 10 connected to the opposite ends of the 10 mega-ohm resistor 8. Then, heat of $\Delta Qt = (V^2t)/(4.2\times10\times10^6)$ cal per second is generated at the resistor 8. When heat is generated at the resistor 8, the temperature of the resistor increases and becomes higher than the temperature of the other portions in the thermal equilibrium system. In spite of the lapse of time, the voltage applied to the resistor 8 persists and is continuously measured. This means that electric energy is continuously supplied to the resistor 8 and simultaneously the resistor 8 continuously generates heat. Since the system is a self-contained system, the electric energy supplied to the resistor 8 is energy converted from some energy in the system. Since there is no energy source, we cannot help to consider that thermal energy in the system has been converted to the electric energy supplied to the

resistor 8. Further, the heat generated by the resistor 8 is supplied to portions of the system other than the resistor. In the way described above, an energy cycle is established in the system, in which ~~thermal energy of the system is automatically converted to electric energy and the electric energy is~~ converted again to thermal energy by resistor 8. Also, in the energy cycle, the means for converting the thermal energy into electric energy is the very apparatus of the invention. The interior of the system is in a thermal equilibrium state in which only the resistor 8 is hotter than the other portions which are at the same temperature. That is, the resistor 8 is maintained at a higher temperature by the heat continuously supplied from a colder portion of the system to the resistor, which is the hotter portion of the system. A means for supplying heat is electric energy generated by the construction of the invention, and a source of the electric energy is also heat. Therefore, the thermal energy of a colder portion is introduced to the resistor as the thermal energy itself after experiencing energy conversion to the electric energy. In other words, the apparatus of the invention enables heat to spontaneously flow from a heat source of a lower temperature to heat source of a higher temperature. This phenomenon contradicts *"Expression 2"* for the second law of thermodynamics.

Next, it is well-known that when a switch such as the switch 7 in the invention is turned on, a voltage V is developed across the resistor 8 and thus a current I flowing in the electric circuit 6 has a value of V/10mega-ohm due to the equation I=V/R. The current represents an orderly state of electrons. This implies that the state of the electrons has changed from a disorderly state, one in which the switch has been turned off, to an orderly state, one in which the switch has been turned on. The thermal equilibrium state is equivalent to a state having a maximum entropy value or a totally disorderly state. When the switch is turned on, a current flows through an electric circuit. The current can be interpreted as a result of a rectification of thermally moving electrons or a phenomenon in which disorderly thermally moving electrons become orderly thermally moving electrons. Also, from a view of thermodynamics, the current can be understood as a phenomenon in which the entropy decreases and one which does not accord with the second law of thermodynamics. That is, presentation of measured spontaneous output of a voltage in a thermal equilibrium system verifies that it contradicts the second law of thermodynamics. Further, since voltage is proportional to current, which is proportional to a degree of order, it can be said that

voltage is proportional to entropy variation. This relation can be expressed by equations: $\Delta Q = CV^2$ (where C is a proportional constant and is equal to $1/(4.2\times R)$ wherein R is resistance of a resistor; and $\Delta S=\Delta Q/T$ (where ΔS represents entropy variation). This relation also contradicts "Expression 3" for the second law of thermodynamics, "Change in nature progresses only in a direction from a state of order to a state of disorder".

Third, according to the phenomenon observed in experiments, it is obvious that the high temperature heat of the resistor 8 irreversibly flows to the low temperature region in the system to increase the entropy and orderly electrons are discharged to return into a disorderly state so as to increase the entropy. This phenomenon continues. According to the current knowledge, it is defined that a self-contained thermal equilibrium system has an entropy which does not exceed a predetermined maximum value nor increase any more. However, the labor (i.e. work--force x distance) of moving the magnet 11 to approach a boundary of the system beyond a predetermined limit does not supply energy into the system, and an entropy increase is continuously observed after the operation of turning on the lead switch (in spite of energy consumption) (entropy increases, $+\Delta S = \Delta Q/T$).

In a self-contained thermal equilibrium system having a predetermined maximum entropy value, when entropy continuously increases in a particular portion of the system (energy is spontaneously consumed as confirmed by experiments), the entire entropy of the system cannot be prevented from exceeding the predetermined maximum entropy value without spontaneous decrease of entropy (spontaneous production of energy) in any other portion in the system (entropy decrease, $-\Delta S = -\Delta Q/T$). In other words, the production of the electric energy must be spontaneous. Further, a continuous decrease of entropy corresponding to the continuous increase of entropy must occur (see page 29, lines 4 to 7, in the original specification). This implies that energy production and consumption continue in the thermal equilibrium system without any more increase of entropy value of the system under the original maximum entropy value. This also contradicts "*Expression 2*" for the second law of thermodynamics, signifying that all the natural processes of every production and consumption are necessarily followed by continuous increase of entropy. Therefore, spontaneous generation of an electromotive force in a thermal equilibrium system is equivalent to the

phenomenon wherein heat flows from a low temperature area to a high temperature area, a phenomenon wherein energy is continuously produced and consumed without an increase of entropy, ~~or a phenomenon wherein a disorderly state spontaneously changes to an orderly state, which are~~ phenomena that contradict the second law of thermodynamics, which is general knowledge, as described above.

Attention must be paid to the fact that the expressions for the second law of thermodynamics cited in the textbooks contain no exact numerical value. This implies that the Examiner's requirement for a plot of entropy, error bars, etc., which contain exact numerical values to verify that Applicant's invention contradicts the second law of thermodynamics, is unwarranted.

(3) Applicant's opinion to rejection reason "I-1-3"

In most of the tests for verifying the invention, the detected value of the output voltage was 1 mV or so (see page 7 line 2 in the original specification). In the detected value, thermal electromotive force and electrochemical electromotive force are error factors. Through actual tests repeated more than a thousand times, it was confirmed that the thermal electromotive force has an error within the error allowance of the meter itself which is less than 0.1 mV. In particular, the electrochemical electromotive force was never measured at all. Through the Examiner's pointing out, Applicant noticed that the specification contains no description for errors, which Applicant acknowledges is Applicant's fault. Applicant solicits the Examiner's understanding for measurements and tests under a specific condition of a thermal equilibrium state, by the reasons as follows.

It is wrong to require error analysis for non-equilibrium factors on the basis of values obtained in the tests carried out under a thermal equilibrium state. If a thermal equilibrium system contains a non-equilibrium portion of such a degree as to require error analysis, it cannot be said that the system satisfies conditions for a test of the thermal equilibrium system. Thus, Applicant raises the question whether it is not so that it is impossible to carry out the test itself. Also, it is questioned if it is easier and simpler to try to meet the thermal equilibrium state than to perform the error analysis.

The presented test voltage value is a value obtained in tests under the condition and assumption that an isolated thermal equilibrium system has been already established. It is inevitable ~~that a real test cannot be performed in a perfect thermal equilibrium system but can be performed~~ only in a system having a difference from a perfect thermal equilibrium system. However, the test itself will be meaningless if the difference is not negligible. After confirming an establishment of a thermal equilibrium system within error allowance of the meter to be used through many pre-tests and calculations, real tests were performed in the established system, so as to obtain the test values. Therefore, the test values cannot have an error due to non-equilibrium but may include the meter's own error.

Regarding the possibility of error due to temperature differences, Applicant has confirmed that the maximum thermal electromotive force which can be caused by a temperature difference of 0.1 °C, when an Si wafer has a thickness of about 0.7 mm, does not exceed 0.05 mV an output voltage. This is a sufficiently large value at a carrier density of the used material. Further, the used meter has an error allowance of 0.1 mV corresponding to 0.05 of 200 mV.

In order to examine for the possibility of error due to chemical potential, the output voltage was measured from a lamination having a Si-SnO_2 contact surface and a lamination having Si-Ge-SnO_2 contact surfaces (including a thick Ge layer as an interlayer), the laminations being similar to the sample for the tests but without any Ge nano particles. However, the measurement by means of a 10mega ohm voltmeter showed no trace of output voltage at all. For reference, Ge has an electrode potential of about -0.15 V, Sn^{+2} having an electrode potential between -0.14 and -0.136 V, Sn^{+4} having an electrode potential of +0.15V, and H_2 having an electrode potential of 0.0V. Therefore, a voltage of maximum 300 mV can be outputted. However, the voltage can be measured only when there exists an electrochemical current I. When the reaction speed is extremely slow, if the resistance is not extremely large, the voltage may not be measured ($V = I \times 10$ mega ohm).

The contact surface was formed by sputtering, in which case the collision energy between atoms is known as being more than several tens eV. Further, in sputtering, a considerably high temperature continued for more than one hour, even without a heater. Therefore, it is considered reasonable to conclude that the portion under a condition in which the reaction is possible has

experienced the reaction nearly completely. Two materials in contact with each other have large conductivities and are expected to end their reaction within a short period of time due to extreme ~~self-discharge when there exists an electrochemical electromotive force.~~

The meter error has both a possibility of being added to the presented measurement value and a possibility of reducing the presented measurement value. Therefore, the following expression is not necessarily valid.

True value = Measurement value - Error

1 mV was presented as a general measurement value?? (Please refer to "(2) in '4. Results of the Measuring and Applicant's Opinion' of the "Exhibit A to Declaration of Chang Je Cho Under 37 C.F.R. 132, which was filed on March 5, 2003), and the following expression is valid.

1 mV = True value + Error

As noted from the above expression, the error has a maximum limit of 1 mV, which means 'error ≤ 1 mV' always. Herein, the general measurement value 1 mV implies an output value in the case where the sizes of nano particles and the width of the rectifying barrier go slightly beyond a range of the conditions for the function of rectifying thermally moving electrons, and the real error of the general measurement value 1mV is smaller than 0.1 mV. In consideration of the object to use the presented measurement value, a minimum limit for the error is not necessary. Therefore, the following equation is obtained.

Presented Measurement value (as shown in table and graph) – 1 mV = True value

In this equation, the 'True value' is always valid, which implies that a true value (5 to 8 mV) containing no error at all is obtained by subtracting 1 mV from the presented measurement value (6 to 9 mV). Also, according to Applicant's experiences of tests up to now, it is concluded that the error contained in the general measurement value 1 mV is less than 0.1 mV which is equal to the error allowance of the meter.

It should be noted that the measurement value is necessary in order to determine whether or not the presented sample generates an electric output. Accordingly, only a value large enough to be

differentiated from the error by the current knowledge of science is necessary, and an exact numerical for the measurement value is not necessary. Therefore, the voltage value of 5 to 8 mV, ~~which is obtained by subtracting the maximum error 1 mV from the presented measurement value~~ 6 to 9 mV, is surely the true value.

On an assumption that the presented test voltage 5 to 8 mV is generated by a thermal electromotive force, a temperature difference of 10 to 16 °C is necessary in consideration of the carrier density ($10^{18}/cm^3$) of the used material and the maximum capability of a thermal electromotive force for known materials. However, in a natural state, it is impossible to maintain the temperature difference of 10 to 16 °C on both surfaces of a carrier Si wafer with an interval of 0.7 mm. Therefore, the presented test voltage has no relation to the thermal electromotive force.

When potential values measured on the same test condition are given as data A and data 6A in a general test, it is decided that the error cannot exceed value A. The relation between the true value and the error is determined according to the object of the test.

Whether there ***exists*** the rectifying phenomenon of thermally moving electrons can be determined only by the following relation.

Minimum True Value > Maximum Value of Error

If the maximum value of error, 1 mV, included in the measurement value 6 mV is eliminated, a minimum true value 5 mV is obtained. If a minimum error of -1 mV is added and thus the measured value is 6 mV, the true value becomes 7 mV. Therefore, either the minimum error or a true value larger than the minimum true value cannot participate in the determination.

An exact value of the true value is necessary in order to compare the true value with the exact value of error when the difference between the true value and the error is very small. If the presented test value were about 1 mV, the issue of error would have been dealt with more precisely and detailedly. Further, a more precise and detailed discussion about the issue of error would not have been sufficient for proving the existence of the rectifying phenomenon of thermally moving electrons. When the true value is fifty times of the real error 0.1 mV, a numerical analysis of the error is meaningless. Therefore, a sufficiently large true value measured at a thermal equilibrium

condition makes the very discussion about the error meaningless. If the presented test values and description of the measured contents can make the "minimum true value" and the "maximum limit ~~of the error" be understood, they can be materials for determination of problems. It is wrong to~~ neglect them by the reason that they are not dealt in a general method of dealing with data.

It is relatively easy to prepare a condition for a thermal equilibrium test within the range of error allowance of the meter. The condition for measurement of presented test values corresponds to a condition for a thermal equilibrium test sufficiently within a range of the error allowance of the meter, although there is a temperature difference of 2 °C between the initial temperature 22 °C and the final temperature 20 °C in the measurement with a time interval of 12 hours. The basis of this conclusion can be found in the following description.

The portion of the system in which the thermal electromotive force is generated is dominated by a temperature difference between opposite surfaces of the Si wafer. In a calculation under a condition that the Si wafer (carrier density of $1.510^{10}/cm^3$) has a density of $2.328 g/cm^3$, a heat Capacity of 0.19 cal/g/°C, and a thermal Conductivity of 0.35 cal/cm/sec/°C, when the temperature difference between opposite surfaces of a 11mm11mm×0.7mm Si wafer is 0.1 °C, a heat moving perpendicularly to the surfaces per second is calculated as 0.6 cal. Heat required for increasing the temperature of the entire wafer of 0.2 g by 1.9 °C is 0.0722 cal.

In a state where the temperature difference between the opposite surfaces of the wafer is 2 °C, a time period during which the heat transfers from a higher temperature surface to a lower temperature surface of the wafer in the rate of 0.6 cal/sec, which is the heat transfer rate when the temperature difference between the opposite surfaces of the wafer is 0.1 °C, to make the lower temperature surface reach 1.9 °C is calculated as a value within 0.120 second (Equation: $1/0.6 = x/0.0722$). That is, the time period T during which the state where the temperature difference between the opposite surfaces of the wafer is 2 °C changes to a thermal equilibrium state where the temperature difference is not larger than 0.1 °C is less than 0.12 second ($T < 0.12$ second). This implies a phenomenon wherein the thermal equilibrium system spontaneously eliminates a non-equilibrium event to return to equilibrium state at a high speed within one second. Therefore, a slow increase or decrease of the entire system does not have a substantial influence on the thermal

equilibrium condition. For example, the speed of 2 °C per each hour in applying the temperature difference (temperature increase/time) is nothing but 0.12/3600 of the speed at which the system spontaneously returns to its thermal equilibrium state, thereby having nearly no influence on the thermal equilibrium condition. Since a thermal electromotive force by a temperature difference of 0.1 °C is not larger than 0.05 mV and the meter error is 0.1 mV (200mV0.05%), it is noted that the presented measurement value has been measured in a thermal equilibrium system within the range of the error allowance of the meter.

For reference, in order to maintain the temperature difference between the opposite surfaces of the wafer to be 0.1 °C, the applying speed of heat (temperature increase/time) to one surface must be maintained at 2 °C/0.12 second. That is, said one surface must be in contact with a heat source, the temperature of which continuously increases at a rate of 2 °C/0.12second. In another expression, the temperature difference of 0.1 °C can be maintained only when said one surface is in contact with a heat source, the temperature of which increases by 166.7 °C for 10 seconds. Therefore, the value "2 °C/0.12 second" is a "maximum temperature-increasing speed" which can maintain the temperature difference between the opposite surfaces of the wafer below 0.1 °C. Even in an environment for the test, the temperature of which continuously increase or decrease, if the temperature-increasing speed has a value not larger than "2 °C/0.12second", it implies that a thermal equilibrium system containing a wafer having opposite surfaces, the temperature difference between which is not larger than 0.1 °C, has been established. The temperature-increasing speed "2 °C/12hours" of the presented test conditions is much smaller than the maximum temperature-increasing speed "2 °C/0.12second". Therefore, the presented measurement value can be said to be a value measured in a nearly complete thermal equilibrium system. This implies that a general indoor temperature environment is provided with thermal equilibrium conditions making it unnecessary to consider non-equilibrium error factors. When the heat is not continuously supplied to the wafer, the temperature difference 2 °C between the opposite surfaces of the wafer may be reduced to 0.1 °C within 0.12 second. In a some calculation, a temperature-increasing speed of 200 °C/0.12 second is obtained as a value in order to maintain the temperature difference 10 °C between the opposite surfaces of the wafer. When the heat is not continuously supplied to the system in a

state of having a temperature difference of 10 °C, the system becomes a thermal equilibrium system with a temperature difference less than 0.1 °C within 0.63 second. Therefore, a temperature difference of 10 °C cannot exist in a thermal equilibrium system.

On an assumption that the true value 5 mV measured in a test is a thermoelectric electromotive force, we meet an inconsistency that the system is possible only when a temperature difference of 10 °C continues and the system requires a temperature-increasing speed of "200 °C/0.12 second". Since the temperature-increasing speed of "200 °C/0.12 second" implies a heat source the temperature of which continuously increases at a speed of 1666.7 °C per each second, we meet an inconsistency that there exists a heat source of 8333 °C which can be confirmed through an observation for five seconds. This completely disproves any basis for relating the measurement true value 5 mV to thermoelectric electromotive force. A system in which high and low temperature portions continuously coexist is not a thermal equilibrium system, although it can continuously output electricity. Herein, 0.12 second is a sufficiently large value with allowance and can be further reduced when exactly calculated. That is, the real speed of returning to a thermal equilibrium state is faster. The above-mentioned discussion is necessary because an actual thermal equilibrium system inevitably has a deviation from the completely ideal thermal equilibrium system.

The output voltage of the sample of the present invention measured on November 25, 2003 exceeded 300 mV, and it is thus Applicant's opinion that the output voltage having such a magnitude can make a further discussion about the topic of error unnecessary.

Further, Applicant can provide results of tests which can answer possible questions about the possibility that electromotive force may be generated by chemical potential. Applicant would provide such results of tests if requested, although Applicant omits submission of them since their contents are too large.

(4) Applicant's opinion about rejection reason "I-2"

In place of submitting Applicant's opinion on this item, Applicant cites the following Applicant's opinion about rejection reason III-2.

II. Applicant's opinion on the rejection reason by the 'Response to Arguments' in Final Office Action

<< Rejection Reason by Examiner>>

With regard to the traverse of the rejections under 35 U.S.C. 112 and 101, Examiner indicates that Applicant's disclosure fails to enable how his device "contradicts the second law of thermodynamics" (cf. e.g., page 5, line 5) and also fails to disclose that his device operates under a law of different from that of the second law of thermodynamics (as alleged on page 9 of Amendment A). In connection with this indication, Examiner presents grounds as follow: no comparison has been made between the data and what is expected by applying conventional theory, and no effect has been made to present a true data plot by including error bars based on a comprehensive inclusion of error sources is common in the physical sciences.

<< Applicant's Opinion>>

(1) Regarding contradiction of the apparatus of the invention of the second law of thermodynamics

According to second law of thermodynamics, thermal energy cannot be transformed into mechanical energy in a thermal equilibrium system. For example, the Carnot engine has an efficiency $E_c=(T_1-T_2)/T_1$, wherein T_1 is the temperature of the lower temperature heat source and T_2 is the temperature of the higher temperature heat source. In a thermal equilibrium system, $T_1 - T_2 = 0$, so that $E_c = 0$. That is, mechanical energy cannot be obtained from thermal energy in a thermal equilibrium system. In other words, since no other type heat engine can ever be more efficient than a Carnot engine, which means that an actual producible engine has an efficiency E_a not larger than the efficiency E_c of the Carnot engine ($E_a < E_c = 0$), thermal energy can never be transformed into mechanical energy at all in a thermal equilibrium system. Therefore, it is a common knowledge that there exists neither any construction nor any means, which can produce the output voltage in a thermal equilibrium system. This is also the reason why the measurement value in a thermal

equilibrium system cannot have any other error factors than the output voltage value by the effect of the present invention.

However, it can be confirmed that an electromotive force can be obtained in a thermal equilibrium system by the apparatus of the invention. That is, although the measurement was performed under circumstances without any other available energy source (e.g. chemical potential energy), the conclusion "*an output voltage exists*" is obtained. Therefore, it can be estimated that the heat in the thermal equilibrium system has been transformed into the electromotive force. In other words, the determination whether the apparatus of the invention contradicts the second law of thermodynamics or not is to determine whether "***no output voltage exists***" or "***an output voltage exists***". Applicant would like to ask if the Examiner has a conclusion that the actual measurement value provided by Applicant contains no true value at all. If the actual measurement value contains a true value, such a case can be utterly differentiated from the case with "no true value at all", even though the contained true value is extremely small and cannot be expressed by a particular numeral. This proves the contradiction of the apparatus of the invention to the second law of thermodynamics. However, the principle or law in which the apparatus of the invention generates such an energy transformation, i.e., the rectifying phenomenon, requires future efforts for clarifying the principle or law. Applicant does not consider such a principle or law as an indispensable requirement for the grant of patent to the present application.

(2) Regarding the reason of rejection that Applicant did not provide a true data plot including error bars

In place of submitting Applicant's opinion on this reason, Applicant cites the following Applicant's opinion about rejection reason 'I-1-3'.

III. Applicant's opinion on the objection by the 'Specification' in Final Office Action

<< Objection Reason by Examiner>>

(III-1) Examiner indicates that Applicant's statements that his invention contradicts the second law of thermodynamics and the rectifying function of the device as being able to operate without supply of energy are not substantiated, considering the absence of a plot of entropy as a

function of time or the equivalent of it. In addition, Examiner suggests that Applicant should provide that plot in a manner that enables a straightforward verification of said statement or withdraw all reference to the device as a rectifier and the rectifying function of said device in the sense given to this term by Applicant, namely as a device and function, respectively, capable of defying the second law of thermodynamics, to operate without the supply of energy, or the physical equivalent of such statements.

(III-2) Furthermore, Examiner indicates that the specification is inconsistent with the Declaration under 37 C.F.R. 1.132.

(III-3) In addition, Examiner requires that Applicant should resubmit the specification with all material pertaining to the above-mentioned objections fully removed.

<< Applicant's Opinion>>

(1) Applicant's opinion on the objection reason "III-1"

Applicant's assertions in the specification, Declaration, etc., are derived from actual manufacture and tests of many samples. Thus, Applicant believes that they are right. Therefore, Applicant does not deem it necessary to withdraw Applicant's assertions. Further, in verifying that Applicant's assertions are correct, Applicant does not regard the Examiner's requirement, that is, a provision of a plot of entropy with respect to time or the equivalent of it, as the sole method of proof. Applicant has already verified through another method than the provision of a plot of entropy that the effect of the present invention is a phenomenon contradicting the second law of thermodynamics. Applicant considers it to be sufficient.

Applicant would like to register an additional Applicant's opinion in relation to this problem that the expression "without a supply of energy" is made through omission of a word "apparent" from the original expression "without apparent supply of energy" in the course of translation from Korean to English, as is fully found in Japanese translation. Moreover, the expression "without supply of energy" can never be said that it is wrong, since the thermal equilibrium system cannot be an energy source for producing mechanical energy in the view of the second law of thermodynamics.

(2) Applicant's opinion on the objection reason "III-2"

(2.1) Regarding the material characterization of Germanium

~~It is reasonable that Germanium is understood as metal in the classification of materials and~~ semiconductor in the classification according to the electro-conductivity. Therefore, Germanium is considered as either a metal or a semiconductor.

Germanium is classified as a metal in a column under the title "properties of pure metals" (1205 page) in "METALS HANDBOOK" - 8th Edition: VOL.1: Properties and Selection of Metals issued by American Society for Metals (Second Reprint, March 1964). The column says that Germanium has a resistivity of 46 ohm-cm (at 300 K) and a carrier density of 2.4×10^{13} per cu cm (at 300 K) which is about 1/4600 of the carrier density of Ge employed in the tests of the present invention. In other words, a material having a resistivity several thousand times as large as the resistivity of the material used in the tests of the present invention is classified as metal in the book issued by American Society for Metals. Therefore, it is reasonable that Ge is considered a metal as well as having a resistivity of a semiconductor. Furthermore, lines 7 to 8 in page 35 of the original specification clearly show that P-type or N-type semiconductors may be nano particles.

(2.2) Regarding the method of forming nano particles

1) Method of forming uniformly distributed nano particles

In forming nano particles used to obtain the test values, a temperature of a substrate (P-type Si wafer) is maintained within a temperature range of 320~470 °C, the substrate is spaced 100 to 150 mm from an evaporation source, and Ge is heated (e.g., to a temperature of about 1300°C) by the evaporation source (an Mo heater) in a vacuum state with a pressure of 110^{-6} Torr ~ 5×10^{-5} Torr, so that Ge can be deposited by a method of evaporation and vacuum deposition.

As is public knowledge disclosed by many documents in the art, Ge particles stuck on a surface of the substrate spin round on the surface, so that each group of several Ge particles gather to form a crystal nucleus, which develops to form a minute crystal grain. As the deposition continues, continuous vacuum deposition layers may be formed after experiencing a state of the island structure (line 9 of page 9 of the specification). In such a process as above-mentioned, the

deposition is stopped in the step of forming the island structure, so that the incompletely deposited substrate with the island structure can be used.

The uniform distribution, uniform size, and uniform dispersion of the metal particles in the specification are expressions for the apparatus of the invention in the best condition, which can make an ideal and best output. In selecting this method, Applicant considered the possibility of satisfying at least an extremely minimum small portion of the best condition and expected an electric output (about 50 mV) sufficient to verify the enabling of the invention, which came true more than expected.

The output of the voltage, which is an effect of the apparatus, that is, construction according to the invention, is a result of collection of parallel output voltages of nano particles. Therefore, each nano particle corresponds to a perfect basic construction of the construction, and the whole can be understood only if a method is understood in which such a basic construction is formed. Hereinafter, an issue of controlling the size of one nano particle in order to achieve the effect of the present invention will be discussed in detail.

When nano particles are made from a general metal, the nano particles formed by the vacuum evaporation deposition just before the island structure is formed are reduced mainly by a DC inverse sputtering (tests were performed with output voltages of 1 to 3 mV). However, Ge is directly used without reduction. It is known that there are fairly large deviations in sizes of the nano particles formed by such a method. In consideration of the sizes of the particles, particles having a size proper for the generation of an electromotive force are supposed to contribute to the generation of the electromotive force, particles having too small a size may not contribute to the generation of the electromotive force, and particles having too large a size are supposed to have a side effect of reducing the already generated electromotive force. According to Fermi-Dirac's distribution function, since the retained kinetic energy of an electron also has a deviation, a collision of an electron retaining a large energy with a minute nano particle will help generate the electromotive force. Therefore, it may be interpreted that there is room for allowing deviations of some degree in sizes of the nano particles. From the standpoint of probability and statistics, Applicant expected that

sizes within a predetermined range can achieve considerably useful results in tests, although the optimum size is most preferable.

Nano particles of P- or N-electroconductive materials located at the P-N junction surface may become a depletion layer by a semiconductor in contact with the nano particles, having an opposite conductivity, so that they cannot form elecroconductive particles, when the carrier density of the nano particles is much lower than the carrier density of the P-N junction surface material or the nano particles have too small a size. However, a proper use of this phenomenon allows formation of elecroconductive particles, an actual example of which is given in the following.

A Ge deposition layer is not largely influenced by the conductivity (N-type or P-type) of the original material and is formed as a P-type semiconductor having a carrier density of at least $10^{18}/cm^3$. By means of using the carrier density of SnO_2, which is an N-type semiconductor in contact with the P-type semiconductor, it is possible to make considerably large P-type Ge particles into nano particles without having any non-electroconductive portion by partially making the P-type Ge particles transformed into a depletion layer to have sizes proper for generation of the electromotive force(a method of controlling the sizes of nano particles).

Hereinafter, a process of forming nano particles in manufacturing a sample of an apparatus according to the present invention will be described with reference to reference figure 4.

(A) Ge metal particles 3 are deposited on a surface of a P-type Si wafer 2 by the method as described above. Initially deposited nano particles have a size expressed by line 1-1 in reference figure 4. Herein, the Si wafer used in the process has a size of 11 mm 11 mm and a resistivity of 0.044 to 0.066 ohm-cm and is boron-doped, having been treated by an oxide film elimination process with HF acid after surface-oxidation process for 3 hours in an atmosphere of 1000 °C.

(B) Thereafter, an 18.5% Sb-doped SnO_2 film 4 is formed on the wafer obtained step (A) under the following conditions: without a heater for heating the substrate; with Ar gas; with a gap of 13 mm between the substrate and the target; with a current density of $2mA/cm^2$; and by DC sputtering at DC 340 V for 6 to 10 minutes.

(C) Next, a 3.5% Sb-doped SnO_2 film is formed thereon by sputtering method for 60 to 120 minutes under the same conditions as above; and

(D) Then, an Sn metal electrode 5 is vacuum-deposited thereon.

Steps (B) and (C) are the steps of forming (inserting) nano particles on the P-N junction. In the above process, expressions "3.5% Sb-doped" and "18.5% Sb-doped" are based on the composition of the raw solution and are thus guessed to be different from actual contained quantities. In manufacturing the target, 3.5% Sb-doped and 18.5% Sb-doped films are formed by spraying the solution on each Si wafer heated to about 500 °C. The sprayed solution contains $SnCl_4.xH_2O$ of 100 g, HCl of 10 cc, H_2O of 50g, and $SbCl_3$ of 3.5 g to 18.5 g (including insoluble portion. Among the targets formed in the above-mentioned method, the 3.5% Sb-doped SnO_2 target is heated and oxidized for 90 minutes at the atmosphere of 700 °C. This step has a close relation to a high output voltage – 305 mV output. (18.5% Sb dope target; heated and oxidized for 30 minutes at 550 to 600 °C)

The test values (graphs 1 and 2) presented below were obtained in a measurement performed on April 21, 2003. In a recent test performed on November 25, 2003, and a maximum output voltage of 305 mV was observed, which is hypothesized to be a state in which a serial construction of P-N junction has been established—(without an Sn metal electrode), and reproducibility for the maximum output voltage of about 100 mV (without an Sn metal electrode) was observed to be nearly 100 %. In reference figure 4, line a-b-a represents a depletion layer in a P-type semiconductor, and line c-d-c represents a boundary of a depletion layer in an N-type semiconductor.

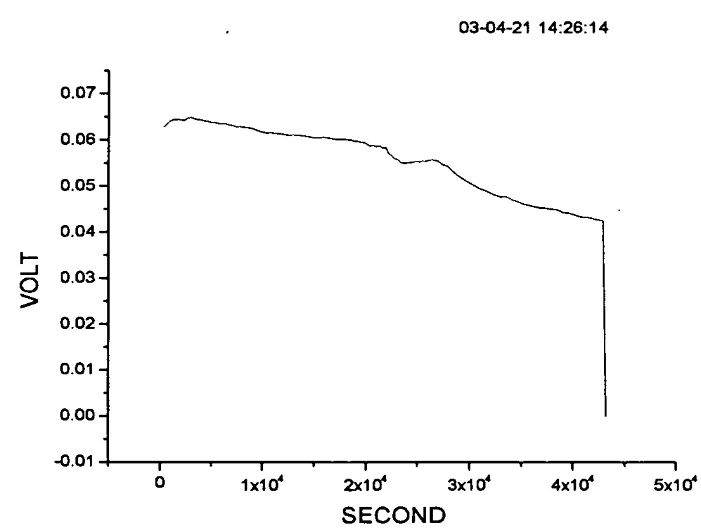
In the above description about the manufacturing process of a sample,

a) When steps (A), (B), and (C) have been completed, regions 1-4 and 4-1 in reference figure 4 make a depletion layer and lose electroconductivity due to the N-type SnO_2 film semiconductor in contact with the regions. In the P-type Ge nano particles, only the portion 4-4 remains as an electroconductor, so that it becomes conductive nano particle with a reduced size. In an actual manufacturing process, numerous tests were performed while adjusting the carrier density of Ge by means of adjustments of the thickness of the films, the carrier density of the N-type semiconductor, the temperature

of target heat treatment, the temperature of the wafer in the Ge deposition, and time period of post heat treatment, so that the obtained final conditions were approached step by step, based on the output voltage in each test. Although the total thickness of the N-type SnO_2 films after completion of steps (B) and (C) as shown in reference figure 4 were not measured, it is small enough to allow the surface state shown in reference figure 4 to have an influence on the P-N junction. An electromotive force of a sample after step (D) is completed was measured as 48 mV in a test.

b) In a sample with an initial voltage of 48 mV, the voltage was observed to gradually increase up to 65 mV (A discharge characteristic with a maximum value is a phenomenon generally observed in a test by a thermally moving electron rectifying apparatus), which is shown in graph 1 obtained by recording the measured voltage after passage of about 2 hours.

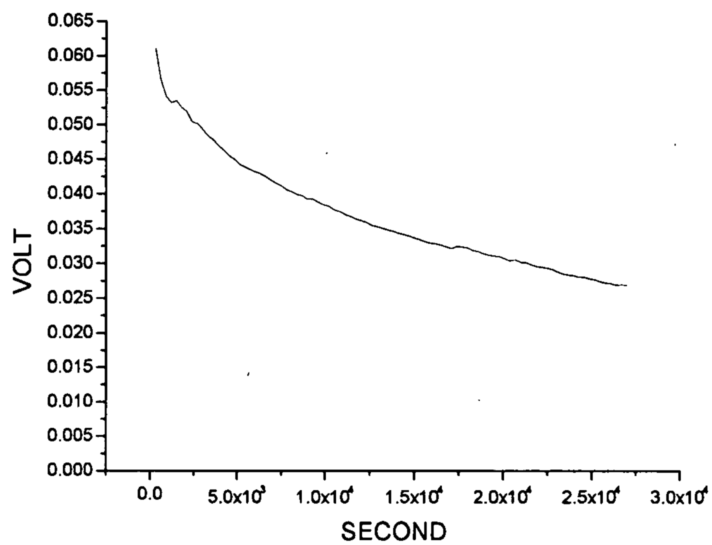
<Graph 1>



c) After that, the voltage decreased according to the passage of time. After 12 hours from the start of the recording, the voltage dropped to 42 mV (see Graph 1).

d) The sample with an output voltage of 42 mV was vacuum dried for 5 hours in a high vacuum space of about 2×10^{-6} Torr (heated at about 60 °C) and are then cooled at a normal temperature in the vacuum state. Then, the voltage was measured again in the atmosphere. The initial voltage was 61 mV, and the voltage measured after continued secondary discharge for 7 hours and 30 minutes was 26.8 mV. Graph 2 shows such a result.

<Graph 2 >



The above-mentioned steps a), b), c), and d) will be briefly analyzed hereinafter with reference to reference figure 4.

The cause of the voltage increase in step b) is concluded to result as follows (Applicant's current conclusion through synthesis of data obtained in many tests). The surface of the 3.5% Sb-doped SnO_2 film is in an active state after the sputtering. Therefore, a change in the surface state or level, caused by moisture stuck to the surface directly after the surface is exposed to the atmosphere from the vacuum state, may enhance an inversion region formed on the surface of the 3.5% Sb-doped SnO_2 film, thereby decreasing ($N^+ \rightarrow N$) the influence of the N-type semiconductor (SnO_2) on the sizes of the P-type Ge nano particles and thus increasing the electroconductive portion of the P-type Ge nano particles. After passage of about 3 hours, the nano particles are considered to have the size 2-2 of reference figure 4, similar to the size 3-3, which is the most proper size. As time passes further, the activity of the surface gradually deteriorates. In addition, the effect of the N-type semiconductor (SnO_2) is enhanced. As a result, the size of the nano particles decreases to line 4-4 and strays far from the most proper size, and thus, the voltage decreases. This analysis is supported by the test d). When vacuum drying for 5 hours has eliminated moisture in SnO_2 film and restored the surface activity to a certain degree so that it becomes nearly the same as the initial state, the nano particles have a size approaching 2-2 and restore nearly the highest voltage. However, they are still in a state inferior to the initial state. Again, the influence of the moisture begins to be observed. The speed at which the voltage decreases is larger than that in the case of the initial discharge. This is interpreted as a complex phenomenon including a gradual change of characteristic of the N-type semiconductor film and a gradual deterioration of the surface state, which was supported by many tests, although description of the tests is omitted here. The change in the surface state and the carrier density of the N-type semiconductor film changes not only the size of the nano particles but also the intervals between them and the width of the rectifying barrier.

Applicant would like to submit concluding remarks as follows. In the above description, a method of forming nano particles which can achieve the effect of the present invention has been discussed. However, the method is just an expedient for overcoming such insufficiency as incompleteness of the apparatus, deficiency of materials, etc. The tests described above were not done under the best environment with employing a construction which includes a P-N junction from an optimum material enabling free adjustment of the carrier density and nano particles made from

an optimum material. If the carrier density can be freely adjusted, the problems of the surface level and the stacking structure can be solved in a simple and easy manner. However, the result of tests, which shows the relation between the output voltage and the size of the nano particles and an achievement of more than 300 mV as the output voltage, are considered sufficient as the basis for verifying the realization and enablement of the invention.

Followings are additional Applicant's concluding remarks. The method described above utilizes an effect of the inversion region formed on the surface of semiconductors so that the carrier density effect of N-type semiconductor SnO_2 with carrier density $N{\sim}10^{20}/cm^3$ can be weakened, thereby being able to control properly the width of the rectifying barrier and the size of nano particles so as to produce an output voltage which is the effect of the present invention. The inversion region is mainly influenced by moisture and its surface activation becomes weak as time passes. Accordingly, the intensity of the inversion region varies to show loss of the an effect of the electromotive force generation, and in a vacuum environment the electromotive force also immediately disappears as the moisture is eliminated.

In order to make an endurable construction, it is required to properly determine the carrier density of the P-type and N-type semiconductors used. To make an endurable output voltage generating sample with P-N junction materials which has large difference in carrier density, the depth of a semiconductor with a higher carrier density should be suitably determined. When the depth of the semiconductor is excessive, there is needed a solution to offset an effect (As for this, please refer to the 'VI. 3' of this document) due to the excessive depth. As the solution, it is required to form an artificial inversion region. The inversion region of the suggested sample is an inversion region in which a P-type semiconductor is naturally produced on a surface of semiconductor SnO_2 which is an N-type semiconductor (Please refer to the inversion region shown in reference figure 4). An artificial inversion region can be formed at the same location. Applicant confirmed that an electromotive force can be generated in a vacuum environment by means of actual tests that utilize an Cu_2O layer which is P-type semiconductor as the inversion layer for the SnO_2 semiconductor which is N-type semiconductor.

"Supplemental Data"

#1; According to data, a surface resistivity of the 18.5% Sb-doped SnO_2 material is about 200 times as high as that of the 3.5% Sb-doped SnO_2 material.

#2; When the target used in the labor in step (C) lacks a surface oxidizing heat treatment in the atmosphere, the initial voltage of the outputted electromotive force initiates from about 1 mV, increases by 1.5 mV, and then decreases, as time passes.

#3; It is a ruling opinion that, in the vacuum deposition layer of Ge, the P-type semiconductor is formed by acceptors caused by grating defects occurring in the deposition. As time passes, the acceptors experience density change, which is guessed to relate to the size of the nano particles as electroconductors.

#4; The intervals between nano particles are also influenced by the surface state and the carrier density of the N-type SnO_2.

#5; The labor of forming nano particles is simply to disperse the particles on a surface of a single layer. Therefore, the labor of forming the nano particles involves a difficulty incomparably lower than that of the labor of forming nano particles a single electron transistor of which location should be determined in consideration of the relative position to a specific electrode therein.

(3) Applicant's opinion regarding the Examiner's requirement "III-3"

Applicant does not exclude a possibility of complementing the present application through a continuation application. However, Applicant still believes that the original specification of the present application does not contain wrong or insufficient description or expression as presented. The method of inserting nano particles has been described in the description of the method of forming the nano particles and is omitted here.

IV. Applicant's opinion on the 'Claim Rejections-35USC 112' in Final Office Action

<< Rejection Reasons by Examiner>>

(IV-1) Examiner raises a rejection reason on claims 1-10 under 35 U.S.C. 112, first graph, as based on a disclosure which is not enabling. The detail grounds of the rejection reason is that the capability of the "rectifier" device of claims 1-2 and the "method for converting thermal energy into

electrical energy by rectifying thermally moving electrons by utilizing a rectifier" of claim 3 to convert thermal electron energy into electrical energy through violation of the law of thermodynamics, while critical or essential to the practice of the invention, but not included in the claims, is not enabled by the disclosure. Examiner suggests that Applicant should provide verifiable data on the behavior of entropy of the system of Applicant as a function of time.

(IV-2) Examiner raises another rejection reason on claims 1-10 under 35 U.S.C. 112, first graph, as failing to comply with the written description requirement. In particular, Examiner indicates that the claimed "monolayer" (claim 1, line 5) is not disclosed in the Specification and hence constitutes *new matter*.

<< Applicant's Opinion>>

(1) Applicant's opinion on the rejection reason "IV-1"

Applicant's opinion on the enabling of the invention has been fully presented already in the Applicant's opinion on rejection reason 'I'. From the same position, Applicant considers claims 1-10 to be enabled, traversing with the Examiner's objection. This is because Applicant has actually manufactured the apparatus defined in claims 1-10, actually measured the output of the apparatus in a thermal equilibrium state, and confirmed that the apparatus can output a voltage of at least 300 mV (a serial construction by 3 kT electron energy), which is an expected theoretical maximum DC electromotive force. Applicant considers this to be sufficient.

Further, Applicant believes that the key subject matters of the present invention to not only be disclosed sufficiently in the specification for enabling of the invention but also to be sufficiently contained in the claims. The apparatus of the present invention has a simple construction, which includes a P-N junction between semiconductors, contact between a metal and a semiconductor, P^+-P contact, N^+-N contact, and nano particles of a conductive material disposed in a depletion layer formed when a conductive material and a semiconductor are in contact with each other. Claims 1 to 5 can be differentiated from claim 6 according to the widths and functions of the depletion layers located at both sides (a rectifying barrier and an electron movement barrier) of the nano particles. It is the subject matter of the present invention that if the width of each depletion layer has a size which allows electrons to spontaneously pass through the layer and the depletion layer has a

capability of rectification, then thermal energy is transformed into electric energy. Applicant has shown that the three factors, the width L of the rectifying barrier, the size (expressed as a surface area S) of nano particles, and the output voltage V, have a relation defined by an equation $V = Lq/(\varepsilon S)$, which matches well with the results of the tests. In the equation, ε represents a dielectric constant and q represents a quantity of charge of an electron, which is 1.602×10^{-19} C. One who fully understands the subject matters of the present invention can know that the equation contains and says almost everything of the subject matters of the present invention. The subject matter described above is clearly disclosed in the specification, and a complete understanding of the specification enables all of the other problems to be understood and overcome by the existing knowledge. Applicant has knowledge of the related art at an ordinary level.

However, in Applicant's opinion, it is unreasonable to discuss the enabling of a technology, which has never been discussed in the world nor been completely understood yet, without direct tests. If there exists in the world no precedent of a construction manufactured and tested in the same manner as the invention, success of the invented construction is considered to have no relation to failure of a test for a different construction. Applicant acknowledges a phenomenon in a test as a reality having the priority and believes in that there exists no theory nor principle contradicting the reality.

The Examiner indicates that the technological subject in the original claims 1-3 is not included in the amended claim 1. However, Applicant does not consider the Examiner's indication to be exact. The technological subject in the original claims 1-3 is included in the expression in the amended claim 1, "*wherein by means of unit charges .... generating irregular AC potential by heat on respective said nano-particles, ambient temperature of said apparatus in thermal equilibrium state is converted by itself so that said apparatus continuously produces DC electromotive force.*".

For reference, the expression, "*convert thermal electron energy into electrical energy through violation of the second law of thermodynamics*," and the expression, "*heat of a body in a thermal equilibrium state is spontaneously converted into electric energy,*" have entirely the same meaning, and the latter is closer to reality.

As already described above, not only the invention defined in the amended claim 1 but also the invention defined in claims 2-9 and disclosed in the specification are enabling. As already stated, the Examiner's requirement, "*Applicant must provide a plot of entropy as a function of time, in order*

to verify enabling of the present invention", is unreasonable and excessive if the assumption that verifiable data on the behavior of entropy of the system of the application as a function of time are the sole means for the verification of the enabling of the present invention is wrong. However, the phenomenon of the conversion from thermal energy to DC electric energy can be actually confirmed by means of the sample apparatus of the present invention and thus Applicant believes that the verifiable data on the behavior of entropy of the system of the application as a function of time is not considered as the sole means to verify the enabling of the actual phenomenon of the present invention. The theoretical basis for the phenomenon confirmed by the apparatus of the invention, which has been explained in the above in Applicant's own way, may be said imperfect. However, it can be said that Applicant's duty has been fully done because Applicant has presented description about a construction and a manufacturing method of an apparatus so that a phenomenon can be repeatedly reproduced. If there are any insufficient theoretical basis and/or explanations on the phenomenon of the present invention, Applicant hopes that such insufficiency should be an issue which must be researched and studied in the related academic world.

(2) Applicant's opinion on the rejection reason "IV-2"

For the Examiner's attention, the expression "arranged as mono layer and" in claim 1 has been amended to the expression "arranged, regularly and uniformly dispersed in a single layer and.". Support of the amendment can be found in lines 3-6 of page 36 of the specification.

V. Applicant's opinion on the 'Claim Rejections-35USC §101'

<< Rejection Reason by Examiner>>

Examiner raises a rejection reason on claim 1-10 under 35 U.S.C. 101 as lacking patentable utility. The ground of the rejection reason is that in the absence of reproducible and statistically meaningful data in support of Applicant's statement that the "apparatus" device of claims 1-9 and the "method of obtaining a desired DC electromotive force" of claim 10 contradicts the second law of thermodynamics, sa "apparatus" of claims 1-9 and said "method of obtaining a desired DC electromotive force" of claim 10 lack enablement.

<< Applicant's Opinion>>

This rejection reason is based on the assumption that reproducible and statistically meaningful data in support of Applicant's statement are absent. However, Applicant has verified that the apparatus and method in claims 1-10 are enabled. Therefore, this rejection reason has been overcome.

For reference, the reproducibility of the present invention was more concretely confirmed in recent several tests performed on November 25, 2003. In the tests, a maximum average output voltage was observed to exceed 100 mV wherein $V = \sum V_m/n$, V is a mean value of maximum voltages, n is the number of tests, and V_m is a measured maximum voltage (see graphs 1 and 2 obtained in the test April 21, 2003). The value of 100 mV is much larger than a voltage level 50 mV which can be reached by average energy kT (0.026 eV) of unit charges at the room temperature.

Further, an output voltage of 305 mV was measured from a sample manufactured by surface-oxidizing an 18.5% Sb-doped SnO_2 target for about 30 minutes at a temperature of 550 to 600 °C or a 3.5% Sb-doped SnO_2 target for about 90 minutes at a temperature of 700 °C in an atmosphere in the same method. This is an actual experimental fact, and Applicant provided only the information about the method of the test.

The value of output voltage 305 mV corresponds to an expected theoretical maximum output voltage of a serial construction claimed in claim 5 or 6 and is in an incomparably superior condition, in view of practical use, in comparison with the output voltage of 500 mV of Si solar cell. Herein, the error value of a voltage lower than 200 mV is approximate to 0.1 mV which is the meter error. Applicant recommends that the reproducibility of the invention be directly confirmed by an authoritative institute in the United States, in consideration of the importance of the invention, if possible.

VI. Applicant's Concluding Opinion

The examiner's detailed review is appreciated.

Regarding the Examiner's reasons of rejection, Applicant would like to submit present proposals with traverse appeals as follows:

(1) Applicant doubts whether the Examiner has the tools to actively confirm the reality for the content and values in of the tests presented by Applicant, so as to avoid being side trashed by

non-relevant considerations. That is, Applicant wonders whether the Examiner avoids the essence by requiring a plot of entropy as a function of time, which it is nearly almost impossible to obtain for a system consisting of complex materials, and error bars, the statistical meaning of which is unclear in the tests for the invention, and by denying the effect of the invention by the reason of no presentation of such plot of entropy and error bars.

(2) Descriptions on equilibrium systems and thermal equilibrium systems, technical features of the present invention, and relations between these two materials and the second law of thermodynamics are heavily treated by the specification in many parts of it (Please refer to the descriptions of line 3 of page 14 ~ line 5 of page 23 of the original specification). However, Applicant wonders whether the Examiner has conducted the examination in full appreciation and understanding of the teaching of the present specification. Applicant is concerned that: the Examiner may not have understood as yet that the expression "heat of a body is spontaneously converted to electric energy" is perfectly the same as the expression "a thermally moving electron is converted to electric energy through violation of the second law of thermodynamics"; and the Examiner's requirement for a description on the reason why the plot cannot be described on a theoretical basis which does not contradict the second law of thermodynamics shows the Examiner's insufficient understanding of the fact that "there exist no theory or knowledge yet, by which electric energy spontaneously outputted from a thermal equilibrium system can be explained." This is supposed to be caused by the Examiner's insufficient appreciation the contents of lines 16 – 18 of page 1, lines 14 – 22 of page 5, lines 1 – 13 of page 18, lines 14 – 29 of page 28, etc., of the specification.

(3) Regarding the Examiner's reason of rejection, "during worldwide experimentation over since the formulation of the second law of thermodynamics, no reproducible violation has ever been found".

Applicant submits that the effect of the system of the invention should be thoroughly studied and analyzed because "no reproducible violation has ever been found." Applicant should not be required to has no intention at all to meet with an approval of the invention by presenting results of tests only once, which "have not ever been found" and may have a great possible influence. Even Applicant who can obtain the results of the tests as daily works is in a position doubting whether the results of the tests are really true although always obtaining them, and thus Applicant fully understands the Examiner's current position.

However, "no reproducible violation has ever been found" cannot be a basis for a conclusion

that the invention is not enabled, because there are lots of undeniable related test results and data. As research in the nano technology recently has become serious and active, it is a ruling opinion that in the field of nano technology there have been found many cases which cannot be explained by the established conventional theory or law in the field of nano technology. Applicant has not seen an expression in a document, "there are some cases which do not conform the law of entropy in the field of nano technology."

It is difficult for Applicant to expect data required in the examination and preliminarily submit the data, and thus Applicant will submit any data when the Examiner requests. Applicant would like to respectfully request and anticipates the Examiner's careful and thorough examination on the basis of the essence of the present invention.

(4) Meanwhile, after the previous data were submitted to overcome the first Office Action, there had been a rapid progress in quality of test data through several times of tests by Applicant. So, Applicant will submit the related data of tests below.

1) Following is an exemplary actual test to study the relation between depth of the N-type semiconductor SnO_2 layer and an output voltage in a vacuum environment. A 11.5% Sb doped N-type SnO_2 was used in place of the location of 18.5% Sb doped N-type SnO_2 shown in reference figure 4 and a 0% Sb doped N-type SnO_2 was used in place of the location of 3.5% Sb doped N-type SnO_2 shown in reference figure 4. In detail,

a) DC sputtering process with 55/6 mA was performed by using a SnO_2 target (heat-treated at 650 °C for 30 minutes, and having a surface resistance of 200220/cm) made from Sb 11.5% doped composite solution for 30 minutes;

b) Sputtering process with 60/6 mA was performed by using the 0% Sb doped SnO_2 target (treated with surface oxidation at 720 for 90 minutes and having a surface resistance of 40Ω/cm) twice with a time interval for measurement, each sputtering process time being 10 minutes. Then, the applicant tried to measure an electromotive force, but could not monitor any outstanding trace of it.

c) An additional sputtering process by using the same target with b) was performed for 10 minutes (Accordingly, total sputtering process time is 30 minutes) to increase the depth of SnO_2 layer. After this, a little electromotive force (0.16mV) was measured.

d) An additional process was performed by using the same target with c) for 10 minutes (Accordingly, total sputtering process time is 40 minutes) to increase the

depth of pure SnO_2 layer. After this, an electromotive force of 6.47mV was measured.

e) It was monitored that the electromotive force generating effect is reduced after an additional sputtering process to increase the SnO_2 layer was performed for 10 minutes.

f) It was monitored that the electromotive force generated showed greater reduction to 0.14mV after another additional sputtering process to increase the SnO_2 layer was performed for 10 minutes. (The total sputtering process time of steps a)~f) is 90 minutes)

2) Applicant's analytic opinion on the exemplary actual test

a) No error values of non-equilibrium factors are included in the values of measured voltage in the exemplary actual test since a thermoelectric electromotive force due to a little temperature difference and a rectified voltage of induced electromagnetic waves can be causes of the error, but equipment constitution conditions are designed so as to reduce the measured true value.

b) The exemplary actual test shows following important technical features. That is, the samples which show a maximum point value in output voltage in the atmosphere among the presented samples correspond to the state of e) or f), that is, have excessive depth. In addition, it is construe that the temporary voltage output is generated by offsetting the effect of excessive depth with an effect of a temporary inversion region due to moisture. While, it can be said that the samples which show a minimum point value in output voltage in the atmosphere among the presented samples has an optimal depth needed for generating an output voltage or a depth which is a little shorter than the optimal depth.

c) The exemplary actual test has very important meaning in that it can provide three evidences required for proving the enablement and patentable utility of the present invention. That is, the exemplary actual test can prove facts that there exists a phenomenon of generation of output voltage (electric energy) by a rectifying

phenomenon of thermally moving electrons and that the generation of output voltage by the construction (apparatus) of the present invention has no relation with the temperature difference and/or the chemical potential between two abutting substances. In addition, the exemplary actual test can also give clear understandings on the relation between the size of nano particles and the value of output voltage.

Based on the foregoing remarks of the applicant, reconsideration of the application and claims as amended is requested and the Examiner is further requested to pass this case to issuance.

I hereby certify that this correspondence is being deposited with the United States Postal Service with sufficient postage as First Class Mail in an envelope addressed to: Mail Stop AF, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450, on January 14, 2004:

Max Moskowitz
Name of applicant, assignee or Registered Representative

Signature

January 14, 2004
Date of Signature

Respectfully submitted,

Max Moskowitz
Registration No.: 30,576
OSTROLENK, FABER, GERB & SOFFEN, LLP
1180 Avenue of the Americas
New York, New York 10036-8403
Telephone: (212) 382-0700

MM:ck:mjb
Enclosure